

REMARKS

I. Objection to Claims

Claims 1, 4 and 10 are objected to because of typographical informalities. By the present Amendment, the typographical errors to claims 1, 4 and 10 have been corrected. Accordingly, entry of these corrections is respectfully requested.

II. Rejection of Claim 7 under 35 U.S.C. § 112

Claim 7 has been cancelled so issues as to it are now moot.

III. Rejection under 35 U.S.C. § 103(a)

Claims 1 and 3 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Fant *et al.* (U.S. Patent No. 4,519,041).

The Examiner's position with respect to claims 1 and 3 is that Fant *et al.* discloses a surface inspection system that provides for a line sensor using one dimensional imaging of a board, a velocity measuring means 36 which is the position camera 36 that views the slab in a longitudinal direction, or at least a portion of the slab, a sampling control means and an image composing memory. With respect to claim 3, the Examiner's position is that Fant *et al.* discloses control means to correct the image data on the basis of a "degree of slant". This rejection is traversed and it is not completely understood.

First, the reference to sampling control means in Fant *et al.* is to column 4, lines 49-53. This seems to confuse data coming from camera 34, which views the slab transversely, and data from camera 36 which views at least a portion of the slab longitudinally. While extensive use is made of algorithms in Fant *et al.*, as discussed throughout the remainder of Fant *et al.* it is not seen where there is a description of having a sampling control means that controls the image data sampling on the basis of velocity of movement of the work board as is required by claim 1 in this application. Further, with respect to claim 3, the position of camera 36 cannot view the entire slab, especially where that slab is one that is forty feet long (see column 4, lines 27-28). Rather, it seems that the function of camera 36 is more to determine if a slab is simply in position to be viewed. The output of camera 36 is not being used to discern any "out of alignment" of the work piece, nor to correct for that condition. The fact that Fant *et al.* describes the use of a camera such as 36 which has a limited field of view, does not appear to permit the detection of velocity

variations in real time. This should be understood in contrast with the present invention where real time velocity data is being constantly outputted and service as part of the inspection of work boards. The "velocity measuring means" is used for defining the sampling timing of one dimensional image data with the line sensor. Its function is performed by sampling control means. When sampling the surface image data of one board, the number of data sampling points in the moving direction of the board (usually longitudinal direction) is determined by the velocity of the board relative to the data sampling position of the line sensor. This has a direct impact on the quality of the obtained image. For example, even when the same sampling frequency is employed, as the velocity of the board increases the number of image data points (pixels) obtained in the moving direction of the board decreases, thus resulting in a low pixel density. Fant *et al.* is mostly concerned with locating surface imperfections on the metal slabs, determining their character, including noting if cracks are longitudinally extending, whether the cracks are close to an edge, as well as determining the length and width of the imperfection.

Reference is made to "slant at col. 14, line 47, and in col. 16, lines 12 and 17. These references, however, appear to refer to the length/width direction of the surface imperfections, not to the position of the hot steel slab itself, nor is any effort made to determine the angle at which a slab may be positioned relative to the direction of travel.

Further, depending on the position control performance of the transport system, the velocity of the board may be varied during the measurement of a single board.

Claim 1 has been amended to refer to the fact that the line sensor images the elongated work board in lines which are perpendicular to the moving direction and includes two types image data: one for an odd number sampling line and the other for an even number sampling line. Further, the velocity limitation has been amended to state that the velocity measurement occurs in real time for each data sampling position of the line sensor. Further, the image composing memory has been further amended to state that a two dimensional image of the work is formed sequentially by combining the odd line data and the even line data from the line sensor outputs.

It is not seen that Fant *et al.* discloses the type of line sensor data required in claim 1, nor does Fant *et al.* disclose real time velocity measuring. It is not clear that there is sampling control identified in Fant *et al.* as it required in claim 1, and Fant *et al.* does not suggest the

format of two dimensional images by the sequential combination of odd line and even line data from the line sensor.

The reference by the Examiner in Fant *et al.* to a sampling control means, specifically to column 4, lines 49-53, suggests that the data camera 34 scans in continuous lines thus generating a sampled analog image of the slab surface. This reference to "sampled" in Fant *et al.* seems to refer to something occurring in a direction perpendicular to the moving direction of the object to be inspected by the data camera 34. However, according to the present invention, the sampling control means, as described with respect to Figure 5, controls the image data sampling in the moving direction of the board and claim 1 has been amended to state that sampling is accomplished in the direction of board movement. Thus, the "sampling" between Fant *et al.* and the present invention are completely different from each other.

With respect to the term "slant" in claim 3, this refers to an angle of the elongated work board itself as it may be skewed out of a longitudinal alignment within a single plane when moving through the work zone. Fant *et al.* states that his camera must be large enough to acquire an image, in the width direction, over an 88 inch field of view so as to cover not only the 76 inch wide slab but also the slab as it may move plus or minus six inches along the roller table. (See the paragraph beginning on line 29 through line 37). While the Fant *et al.* system is able to compensate for variations in height due to the slab thickness or flatness, there is nothing in Fant *et al.* to suggest that the degree of slant or tilt of the work base relative to a horizontal plane is being determined. Thus, Fant *et al.* does not suggest or disclose the limitations set forth in claim 3. As mentioned previously, Fant *et al.* refers to "slant" in cols. 14 and 16, and these appear to refer to the surface imperfections to track the location of the observed cracks or other imperfections. There is no observable use of "slant" by Fant *et al.* that relates to the whole metal slab, nor is there a suggestion that one correct image data of the work board in Fant *et al.*, as is claimed in claim 3.

Accordingly, it is respectfully submitted that claims 1 and 3 are not properly rejectable under 35 U.S.C. § 103(a) over Fant *et al.* and is respectfully requested that that rejection be withdrawn.

IV. Rejection of Claim 2 under 35 U.S.C. § 103(a)

Claim 2 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Fant *et al.* (U.S. Patent 4,519,041) as applied to claim 1 above, and further in view of Bonewitz *et al.* (U.S. Patent 5,917,602).

Initially, claim 2 depends from claim 1 and as noted above, it is not believed that Fant *et al.* is a proper basis for the rejection of claim 1. Claim 2 is rejected over Fant *et al.* together with Bonewitz *et al.* with the Examiner's position being that Bonewitz *et al.* teaches that it is known to measure rotational velocity by using transferring rollers as suggested in column 9, lines 20-22.

Bonewitz *et al.* deals with the issue of determining whether molded articles, such as glass jars or bottles, contain stress related defects or were somehow not properly molded. A camera is used to create successive images primarily to detect the edges of the container and for portraying two dimensional images from successive images generated by the camera. Bonewitz *et al.* does state that his system includes an electronic control receiving and responsive to the speed for controlling the camera to generate the successive images as a function of speed of the moving container. However, Bonewitz *et al.* does not supplement the deficiencies noted above with respect to Fant *et al.* concerning the development by the line sensor of odd number and even number sampling lines, nor the formation of a two dimensional image from those odd line and even line data. Consequently, it is not believed that the combination of Fant *et al.* and Bonewitz *et al.* would properly serve as a basis to reject claim 2 under 35 U.S.C. § 103(a) as being obvious thereover. Accordingly, withdrawal of that rejection is also respectfully requested.

V. Rejection of Claim 4 under 35 U.S.C. § 103(a)

Claim 4 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Fant *et al.* (U.S. Patent 4,519,041) as applied to claim 1 above, and further in view of Oohashi *et al.* (Japanese Patent 4-46749).

Claim 4 has been amended to state that the surface inspection system for the elongated work boards further includes a transmitting means for assigning every work board a transmission channel that is used to sequentially transmit chronological variation images which are then assembled into a transmission packet and that transmission packet is then transmitted. The Examiner agrees that Fant *et al.* does not disclose this, but takes position that Oohashi teaches

that it is known to include a transmitting means and directs attention to the Abstract at lines 1 through 9.

As shown by Oohashi in his figures, for monitoring state changes of a plurality of devices, Oohashi teaches a system in which image sampling data is collected from the individual devices using a plurality of dedicated monitoring cameras 2, the date is transmitted, and the reproduced on monitors 7. Hence, there is no correlation among the sampling data between individual devices.

On the contrary, in the transmitting system of the present invention, the line sensors arranged for individual processes, which correspond to the individual cameras of Oohashi, take images of the identical object. Specifically, the line sensors take images of the changing surface or external appearance of the object as it goes through the processes. This operation is performed on each of the subsequently transported work boards.

More specifically, monitoring images taken by the individual cameras of Oohashi are independent of one another, and these independent monitoring images are compiled and then transmitted. On the other hand, in the present invention, image data of one board to be inspected is obtained by a plurality of sensors over time. A transmission channel is provided for each board to be inspected, so that the individual image data items for each board can be grouped and handled as chronological variation data for each inspected board.

The transmission channels are individually prepared in the above manner so that, as shown in Fig. 19 of this application, chronological changes in each of a plurality of inspected boards, as they go through each process, can be displayed simply in real time and compared.

Accordingly, it is not believed that there is a supportable basis for the proposed rejection of claim 4 by Fant *et al.* taken together with Oohashi and withdrawal of that rejection is respectfully requested.

VII. Rejection of Claim 5 under 35 U.S.C. § 103(a)

Claim 5 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Fant *et al.* (U.S. Patent 4,519,041) as applied to claim 1 above, and further in view of Mori *et al.* (Japanese Patent 9-11090).

Claim 5 has been amended to indicate that when work boards pass through a plurality of manufacturing processes, the system includes detecting means for detecting the entry and exit of

the work boards into and out of each of those manufacturing processes, that the time measuring means measure times dealing with the entry and exit of the work board as detected by the detecting means, and that the identifying means identify the work board based on a process number representing each manufacturing process and on the entry and exit time for the work board into and out of the processes as measured by the time measuring means.

The description in Mori *et al.* is very meager and seems to merely disclose the provision of a detection means for detecting when an object is present to be inspected. In that regard, detecting means 5 is provided at an inlet of the range 4 and when a work piece 2 moves into that range it is detected by a detecting means 5.

Suzuki *et al.* appears to be an incomplete document in that the solution paragraph on publication 09160982A ends with a line "and the quality state data and the process state data in..." However, based on the incomplete description that is there, Suzuki *et al.* suggests that in a quality control method, there is some time information that is being developed dealing with a time when the product is completed and the time when the product "exist in" the manufacturing process. Thus, even if there is a utilization of time when the product is completed and when it leaves an manufacturing process, unlike the present invention, Suzuki *et al.* does not use such measured times as an identification key for identifying a plurality of work boards as they are being processed through a plurality of various process steps. Further, claim 5 depends on claim 1 and neither Mori *et al.* nor Suzuki *et al.* supplement Fant *et al.* with respect to the areas where Fant *et al.* has already been noted to be deficient relative to claim 1.

Accordingly, it is respectfully submitted that claim 5 is not properly rejectable as being obvious under 35 U.S.C. § 103(a) over Fant *et al.*, Mori *et al.* and Suzuki *et al.* and withdrawal of that rejection is respectfully requested.

VIII. Rejection of Claims 6, 7, 9 and 10 under 35 U.S.C. § 103(a)

Claims 6, 7, 9 and 10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Mori *et al.* (Japanese Patent 9-11090) in view of Suzuki *et al.* (Japanese Patent 9-160982).

It should first be noted that claim 7 and 9 have been cancelled so that this response deals only with pending claim 6 and 10.

The Examiner's attention is directed to the comments above with respect to claim 5 that is very similar to the subject matter of claim 6 since claim 6 also relates to a surface inspection

system before products have passed through a plurality of manufacturing processes with the system including detecting means, time measuring means and identifying means similar to the limitations set forth in amended claim 5 above. Because Mori *et al.* and Suzuki *et al.* would not appear to employ any measured time as an identification key for identifying a plurality of boards as they are being processed, it is not believed that the rejection of claims 6 and 10 as being obvious under 35 U.S.C. § 103(a) in view of Mori *et al.* and Suzuki *et al.* is proper and withdrawal of that rejection is respectfully requested. In addition, the copy of Suzuki *et al.* appears to be incomplete since the text on the single page provided simply stops with words "and the process state data in...". Is a complete copy available?

IX. Rejection of Claim 8 under 35 U.S.C. § 103(a)

Claim 8 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Mori *et al.* (09011090) as applied to claim 6 above, and further in view of Suzuki *et al.* (09160982) in further view of Fant *et al.* (4,519,041).

This rejection is also traversed. It is not seen that Fant *et al.* corrects any of the defects of Suzuki *et al.* with respect to using measured times as an identification key and it is not believed that Fant *et al.* properly teaches that it is known to include a detecting means such as the position camera 36 for detecting leading and trailing end portions of a work product. As noted previously, the metal slabs in Fant *et al.* can be many feet long so that the position camera 36 will have a certain field of view depending upon the entire length of the work base. Where it is 40 feet long, position camera 36 will only view a portion of the iron or metal slab and would not necessarily detect leading and trailing end portions of the work base. Thus, it is not clear what teachings from Fant *et al.* would be useful in Mori *et al.* and Suzuki *et al.*, nor how Mori *et al.* would be modified to include any teaching from Fant *et al.* Accordingly, it is respectfully requested that the rejection of claim 8 be withdrawn.

CONCLUSION

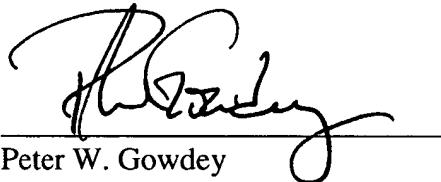
Applicant believes that all claims are now in condition for allowance and withdrawal of all rejections is respectfully requested.

If the Examiner believes that a telephone conversation would advance the prosecution of this application, he is invited to contact the undersigned at the telephone number listed below.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version With Markings to Show Changes Made."

The Commissioner is hereby authorized to charge any additional fees that are required or credit any overpayment to Deposit Account No. 19-2112 referencing Attorney Docket No. HIAS.95176.

Respectfully submitted,



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VERSION WITH MARKINGS TO SHOW CHANGES MADE
IN THE SPECIFICATION:

The paragraph beginning on page 1, line 11, has been replaced with the following rewritten paragraph:

In ~~the~~ a conventional continuous work line ~~of~~ handling work boards, for instance, the shape and color tone of a semi-finished product are frequently caused to change on every occasions after finishing each manufacturing process. For example, in a continuous coating line of building boards, the color tone of the building board is caused to apparently change upon finishing each manufacturing process even if the original shape of the building board or work board is not changed.

The paragraph beginning on page 1, line 24, has been replaced with the following rewritten paragraph:

In such cases, instead of performing an inspection of individual building ~~board~~ boards at each manufacturing process thereof, an inspection process is usually performed at the final stage of manufacturing process so as to perform the inspection on the finally finished product. The building board that has passed through this inspection is then usually marked with a specific manufacturer's serial number so as to make it possible to distinguish each building board by this serial number. The reason for performing the inspection at the final stage of manufacturing process may be attributed to the fact that it is very difficult to uniformly impose ~~the~~ inspection conditions ~~in the~~ at a point midway ~~of~~ through the manufacturing process. For example, the object of inspection may not be moving along a fixed location of transferring line, or the object of inspection just transferred from a drying process may inevitably undergo a physical or chemical change due to a thermal change with time. Namely, the fact that the object of inspection is not necessarily in a stable state ~~in~~ at the midway point of the manufacturing process is ~~seemed to be one of the reasons~~ reason for not performing the inspection ~~in~~ at the midway point ~~of the manufacturing process~~.

The paragraph beginning on page 3, line 21, has been replaced with the following rewritten paragraph:

The present invention has been made to solve the aforementioned problems. Therefore, an object of the present invention is to provide an inspection system which enables even in the

production control section located at a process even at remote place locations and allows one to trace and inspect how large the external appearance of a great number of work boards, that have been placed on a continuous work line, will be changed after undergoing through each manufacturing process.

The paragraph beginning on page 3, line 28, has been replaced with the following rewritten paragraph:

Another object of the present invention is to provide an inspection system which is capable of identifying the each individual work board and of recording the manufacturing conditions of the individual work board even if the external appearance of that work board is liable to change in the manufacturing process of the along a continuous work line.

The paragraph beginning on page 4, line 6, has been replaced with the following rewritten paragraph:

Namely, according to the present invention, there is provided an inspection system, which comprises a line sensor for one-dimensional imaging an elongated work boards, a velocity-measuring means for measuring a moving velocity of the work board, a sampling control means for controlling the sampling of said line sensor on the basis of the moving velocity of the work board to be measured by said velocity-measuring means, and an image-composing memory for composing an output of said line sensor to generate a two-dimensional image data.

The paragraph beginning on page 4, line 19, has been replaced with the following rewritten paragraph:

The inspection system may be further provided with a controlling means to correct the sampled image data based on how the extent to which the work board is slanted or moved out of a normal position, thereby making it possible to easily compare the image data with that of image data of a standard work board or other work board.

The paragraph beginning on page 4, line 24, has been replaced with the following rewritten paragraph:

Further, the inspection system may be further provided with a data transmitting means for assigning a transmission channel to every work bed board and assembling the image data into

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the data-packets so as to ~~transmits~~ transmit them, thereby making it possible to effectively transmit the image data without causing a collision between ~~the lots of~~ many packets of data.

The paragraph beginning on page 6, line 22, has been replaced with the following rewritten paragraph:

Fig. 7C is a diagram illustrating a ~~methode~~ method of calculating the angle of ~~diviation~~ deviation;

The paragraph beginning on page 6, line 24, has been replaced with the following rewritten paragraph:

FIG. 8A is a X-Y ~~eordinates~~ coordinates of a work board;

The paragraph beginning on page 7, line 27, has been replaced with the following rewritten paragraph:

FIG. 1 is a top view illustrating automatically a part of the continuous work line which can be suitably applied to the inspecting system of work board according to one embodiment of the present invention. In the following explanation, a building board 1 is exemplified as the work board. A raw board 1 of the building board goes at first into a manufacturing process (1) in the direction of an arrow A1. After finishing a working in the manufacturing process (1), the work board is inspected at an inspection process (1) and then, moved to the next manufacturing process (2). After finishing a ~~working~~ treatment in the manufacturing process (2), the work board is inspected at an inspection process (2) and then, changes the moving direction to move the next manufacturing process (3). After finishing a working in the manufacturing process (3), the work board is inspected at an inspection process (3) and then, further turned and delivered in the direction of an arrow A3 for subjecting it to the next manufacturing process.

The paragraphs beginning on page 8, line 16 through page 11, line 28, have been replaced with the following rewritten paragraphs:

A great number of work boards 1 are intermittently ~~gone fed~~ at predetermined intervals into the continuous working line in this manner. After finishing a predetermined number of ~~working~~ treatment processes, the work boards ~~are ultimately gone out from~~ exit the continuous working line. During these working processes, the work boards are moving ~~in~~ individually ~~over~~ through the continuous transferring line.

There is an upper limit with respect to the total number of work ~~board~~ boards that can be placed on the transferring line as the transferring lines are steadily operated.

On the other hand, as far as each manufacturing process is concerned, the time when the work board 1 goes into or enters the prescribed manufacturing process as well as the time when the same work board 1 goes out from or exits said prescribed manufacturing process can be represented by an absolute value of time of working (it means that the time elapsing minute by minute would never go back) which is applied to individual work board 1 in said prescribed manufacturing process. The work ~~board~~ board 1 may ~~go into enter~~ and ~~out from exit~~ the manufacturing process at the same moment in other manufacturing processes. However, as far as a single specific manufacturing process is concerned, the time when the individual individual work board goes into enters and out from exits the manufacturing process is a value peculiar to this individual work board 1. This will be specifically explained in the followings below.

For example, assuming that the work line is operated in a steady state, when a work board 1 goes into enters at 10:00 in the manufacturing process 1 and then, goes out exits from the manufacturing process 1 at 10:10 as scheduled, this 10 minutes of working during which this work board 1 has been treated in the manufacturing process 1 can be represented by three data (process number = it 1; going into entry time = 10:00; and going out exit time = 10:10). From these data, it can be shown that this work board 1 lies in the manufacturing process 1 for receiving a treatment during this period of time.

Supposing that this work board 1 goes out exits at 10:15, there is a possibility that any kind of trouble of some kind may has been have occurred in this or other manufacturing process. Specifically, when this work line is temporarily suspended, due to a trouble some problem that has been occurred in this manufacturing process, or in other another manufacturing process, a delay would be caused in the going out exit time. Therefore, it is impossible to determine if the work board 1 to be inspected has been really worked in a steady state, knowing only the going out exit time.

FIG. 2 is a an enlarged schematic view illustrating a main portion of the continuous work line shown in Fig. 1. When the detecting light emitted from a photoelectric switch SW1 is intercepted by the leading end portion of work board 1 as the work board 1 is moved in the direction of an arrow A, the photoelectric switch I detects that the work board 1 goes into or enters a manufacturing process (n). When the light emitted from a photoelectric switch SW1 is

~~no more~~ ~~not~~ intercepted by the trailing end portion of work board 1, the photoelectric switch SW1 detects that the work board 1 going into the manufacturing process (n) is has ended and a ~~going into an exit~~ finish time tie (n) is measured and a scheduled ~~going out~~ exit starting time tees (n) is calculated. When the detecting light emitted from a photoelectric switch SW2 is intercepted by the leading end portion of work board 1, the photoelectric switch SW2 detects that the work board 1 ~~going out from exiting~~ the manufacturing process (n) is started, and a ~~going out~~ an exit starting time tes (n) is measured so as to compare it with the scheduled ~~going out~~ exit starting time tees (n), thereby checking that the work board 1 ~~is gone out~~ has exited. When the detecting light emitted from a photoelectric switch SW2 is ~~no more~~ ~~not~~ intercepted by the trailing end portion of work board 1, the switch SW2 detects that the work board 1 ~~going out from exiting~~ the manufacturing process (n) is has ended and the ~~going out~~ exit finish time tee (n) is measured and a scheduled ~~going into~~ entering-starting time tis (n+1) to the next manufacturing process (n+1) is calculated. When the detecting light emitted from a photoelectric switch SW3 is intercepted by the leading end portion of work board 1 after the work board 1 has passed through an inspection process (n) of the manufacturing process (n), the photoelectric switch SW 3 detects that the work board 1 going into the manufacturing process (n+1) is started, and a ~~going into or entering~~ starting time tis (n+1) is measured so as to compare it with the scheduled ~~going into entry~~ starting time tis (n+1), thereby checking that the work board 1 ~~is gone into~~ has entered.

When the ~~going into~~ entering time is measured and the work board 1 ~~is gone out~~ has exited at a scheduled ~~going out~~ exit starting time in this manner, an inspection or an acquisition of image data is performed. Thereafter, when the work board 1 is moved into the next manufacturing process at a scheduled time after finishing the inspection in the previous process, it is determined that the work board 1 is ~~rendered~~ ready to receive the next working treatment.

As explained above, the measurement of the ~~going into~~ entry time of the work board 1, the measurement of the ~~going out~~ exit time of the work board 1, the determination of whether the work board 1 ~~is has~~ actually ~~gone out from left~~ the manufacturing process at a scheduled ~~going out~~ exit time ~~measured~~ measurement based on the ~~going into~~ entry time, the execution of inspection following the manufacturing process, and the determination of whether the work board 1 ~~is has~~ actually ~~gone into~~ entered the next manufacturing process at a scheduled ~~going~~

into entry time measured measurement based on the unloading time are all designed to be executed by "the manufacturing process controller" for controlling this manufacturing process.

Since the scheduled going out exit time and the scheduled going into entry time to for the next manufacturing process are all calculated estimated values, some degree of tolerance should be allowed in the determination of the actual time in view of possibility of generating a slight degree of error in moving time of the work board 1 due to various factors such as a slippage of a transferring means.

The paragraph beginning on page 12, line 28, has been replaced with the following rewritten paragraph:

FIG. 3 is a schematic view illustrating the arrangement of the inspecting process portion. The manufacturing process controller 100 (to be explained in detail with reference to FIG. 10) is designed to identify each work board 1 on the basis of the time obtained respectively from the photoelectric switch SW1 (for measuring the going into entry time of the previous manufacturing process), the photoelectric switch SW2 (for measuring the going out exit time of the previous manufacturing process), and the photoelectric switch SW3 (for measuring the going into entry time of the next manufacturing process). The work board 1, transferred from the previous manufacturing process by means of the transferring ~~roller~~ rollers 31, is detected by a photoelectric switch SW4, and then, the transferring velocity thereof is detected by a rotary pulse encoder 13. Based on this transferring velocity, the sampling rate is determined, and the surface of the work board 1 is one-dimensionally imaged by means of a CCD line sensor camera 11. The image data obtained by this imaging is accumulated occasionally in a hard disk HDD 16. As a result, even if the work board 1 is moving at a varying speed, it is possible to determine the sampling timing of image data on the basis of output obtained through the measurement by the rotary pulse encoder 13 attached to the transferring roller 31 for measuring the rotational velocity of the transferring roller 13 which is installed immediately below or immediately in front of the CCD line sensor camera 11 positioned over the transferring zone of the work board 1.

The paragraph beginning on page 13, line 28, has been replaced with the following rewritten paragraph:

FIG. 4A is a block diagram illustrating an internal configuration of the CCD line sensor camera 11 shown in Fig. 3. This CCD line sensor camera 11 is provided with two systems for

reading, i.e. a system (1) for an odd number line and a system (2) for an even number line, thereby enabling it to enhance the resolution. The imaged data is fed from each reader to an analog-digital converter 34 (A/D(1), and 44 A/D(2)), respectively, in which they are converted into digital form. As shown in FIG. 4B, the measuring point (1) and the measuring point (2) are positioned away from each other along the transferring or movement direction of the work board 1, ~~to be moved thus~~ in the transferring direction A. These measuring points (1) and (2) are given to be imaged by an optical system (1) 31 and an optical system (2) 41, respectively. The results thus imaged are then photo-electrically converted by means of a line photosensor (1) 33 and a line photosensor (2) 43 which are to be ~~drived~~ driven using a CCD driving circuit (1) 32 and a CCD driving circuit (2) 42, respectively, as shown in FIG. 4A. The analog signals thus obtained through this photo-electric conversion are then converted into digital signals. Then, the RGB data of the odd number line is temporarily stored in a line image memory (1) 35, while the RGB data of the even number line is temporarily stored in a line image memory (2) 45, thereby enabling them to be transmitted to an image compressing memory 12 of the manufacturing process controller 100.

The paragraph beginning on page 15, line 10, has been replaced with the following rewritten paragraph:

FIG. 5 is a diagram illustrating changes of line reading rate. When the moving velocity of the work board 1 is assumed to be 1m/sec., at the initial moment (1), the reading of data-sampling points 1 and 2 is performed, respectively, at the measuring point (1) of the odd number line as well as at the measuring point (2) of the even number line. At the next moment (2) 5 msec after the initial moment (1), the reading of the data-sampling points 3 and 4 is performed respectively at the measuring point (1) as well as at the measuring point (2). Further, at the next moment (3) 5 seconds after the aforementioned moment (2), the reading of the data-sampling points 5 and 6 is performed respectively at the measuring point (1) as well as at the measuring point (2). Whereas, when the moving velocity of the work board 1 is accelerated faster than 1m/sec., the work board 1 is caused to move a longer distance during this 5 seconds, so that the line reading pulse is required to be shifted so as to increase the sampling rate in order to make it possible to read with the same resolution as the previous moving velocity at the moment of (2)'.

The paragraph beginning on page 15, line 28, has been replaced with the following rewritten paragraph:

FIG. 6 is a diagram illustrating the accumulation of image data in an image-composing memory 12 (see Fig. 10). In this embodiment, only ~~an~~ a R (red) signal is illustrated. However, this can be also applied to a G (green) signal as well as a B (blue) signal. Each line image memory 35 or 45 (see FIG. 4) is constituted on the FIFO (first-in first-out) basis and hence, the data can be read out according to the line-reading pulse and written in compression in the image-composing memory 12 of the manufacturing process controller 100. In this case, the odd number line data of row number nn, i.e. Lo1, Lo2, Lo3, ---, Lonn and the even number line data of row number nn, i.e. Le1, Le2, Le3, ---, Len are simultaneously and alternately written while changing the row in the memory 12. In this case, not only the board image data but also the background image data are simultaneously written in the memory 12. However, this problem can be corrected in a subsequent data processing. In this manner, a board image to be inspected can be composed.

The paragraphs beginning on page 17, lines 2 through line 17, have been replaced with the following rewritten paragraphs:

Based on the angle of slant θ thus obtained, the affine transformation is performed so as to obtain ~~an~~ image data where the slant is corrected.

FIG. 8A is ~~a~~ an X-Y coordinate coordinate representation of a work board. When the position (X, Y) is rotated by an angle of θ as the work board 1 is ~~diviated~~ deviated by an angle of θ as shown in FIG. 8B so as to obtain the position (x, y) as shown in FIG. 8A. the following equations can be obtained.

$$x = X \cos \theta + y \sin \theta$$

$$y = -X \sin \theta + Y \cos \theta$$

In this manner, the sampling of board image data on an elongated board which is a moving object to be inspected can be performed accurately in a non-contact manner and at a high speed, and at the same time, when the image data obtained is compared with a standard board image data that has been recorded in advance . This offers ~~a~~ easy detection whether or not the occurrence of abnormality has ~~been~~ occurred.

The paragraphs beginning on page 17, line 23 through page 19, line 19, have been replaced with the following rewritten paragraphs:

FIG. 9 is a diagram illustrating a relationship between ~~an~~ the image data of a composed board (already corrected) and ~~an~~ image data to be displayed. The aforementioned composed board image data is then subjected to a data processing for enabling it to be transmitted to a production controller ~~which is~~ located at a remote place. Namely, the data compression is performed in order to reduce the aforementioned composed board image data to an image size suited for displaying it as a board image in a monitor display 71 (see FIG. 17) which is connected with the production controller. In this case, it is instructed by the production controller that "in what degree of resolution the image should be displayed?", so that the resolution of monitor itself to be actually displayed is taken into account. While the composed board image data is of high resolution for the purpose of inspection, the display image data is of standard resolution. If the composed board image data is; the number of pixel: $md \times nd$; actual size: $Md \times Nd$, while a monitor display 50 is; the number of pixel: $xd \times yd$; corresponding actual display size: $Xd \times Yd$, and if the display reduction ratio β , the actual display size becomes $Md \times \beta \times Nd \times \beta$, and the image data is compressed in such a manner that md pixel and nd pixel become;

$(Md \times \beta) \times (xd/Xd)$ and

$(Nd \times \beta) \times (yd/Yd)$, respectively.

FIG. 10 is a block diagram illustrating the constructions of the manufacturing process controller 100 and those of the production controller according to this embodiment. Detailed operation of these controllers will be explained in the flow chart shown in FIG. 11. The local main controlling section 101 provided with a communication control section 27 is designed to control entirely individual control module. The board specifying section 4 is designed to identify the individual work board 1 by the use of the photoelectric switches SW1 to SW3 (2) and the timers 3 (timers (1) & (2)-3), the result being stored in the memory 5. With respect to the work board 1 thus specified, an abnormal moving thereof is judged by an abnormality determining section 7 by the use of a timer 6 (timer (3) 6) also, the result being stored in a flag register 7a. The sampling control section 10 is designed to control the sampling of the CCD line sensor camera 11 by the use of the photoelectric switches SW4-(8), the timers (4) timer 9 (i.e., (4)) and the sampling rate corrected, on the basis of the pulse from the rotary pulse encoder 13, by a

sampling rate calculating section 14. The image-composing memory 12 is designed to compose and store a corrected line image data fed from the CCD line sensor camera 11. A data compression section 15 is designed to compress the data so as to store it in the hard disk HDD 16, and at the same time, controlling information is also stored in the hard disk HDD 16. A transmitting image data processing section 17 is designed to process the image data for transmission. A transmission packet assembling section 18 is designed to assemble the resultant image data into a transmission packet, which is then held by a packet buffer 19. The packet is subsequently delivered by a packet delivering circuit 20 and then subjected to a digital modulation at a digital modulation circuit 21 and to a frequency conversion for transmission at a transmission CH frequency conversion circuit 22. The resultant data is transmitted from a wave composing circuit 23 via a transmission line to the production controller 200.

The paragraph beginning on page 20, line 13, has been replaced with the following rewritten paragraph:

In the system suspension processing (step S7), a determination is performed as to whether $t_2 = \text{going-out time } t_e(n)$ (the going-out-starting time $t_{es}(n)$ or the going-out-finishing time $t_{ef}(n)$) is abnormal (step S11). If the result is NO and there is no abnormality, a determination is performed as to whether $t_3 = \text{going-into time } t_i(n+1)$ (the going-into-starting time $t_{is}(n+1)$ or the going-into-finishing time $t_{if}(n+1)$) is abnormal (step S12). If the result is NO and there is no abnormality, the operation returns to the step S11 so as to continue watching the occurrence of abnormality. On the other hand, if the result is YES in the step S11 or step S12 and there is any abnormality in t_2 or t_3 , the suspension of inspection is instructed to the sampling control section 10 and the occurrence of abnormality is transmitted to the production controller 200 (step S13). The result of the determination of abnormality is recorded in the flag register 7a. At this time, the timer (3) is started (step S14) and then, it is determined as to whether the inspection should be restarted (step S15). If the result is YES and the inspection is restarted, the operation returns to the step S11. On the other hand, if the result is NO and the inspection is not restarted, it is determined by means of the timer (3) as to whether a predetermined time has elapsed (step S16). If the result is NO and the predetermined time has not yet elapsed, the system forces the operation bring into a state of standby until the predetermined time has elapsed. If the

result is YES and the predetermined time has elapsed, the system- suspending procedure is executed (step S17), thereby finishing the operation.

The paragraph beginning on page 21, line 11, has been replaced with the following rewritten paragraph:

FIG. 12 is a flow chart indicating the operation of the board identification section 4 (see FIG. 2) . First of all, it is determined if the photoelectric switch SW1 is ON (step S21). If the result is NO and the photoelectric switch SW1 is not ON, the board identification section 4 forces the operation to bring into a state of standby until the photoelectric switch SW1 is turned ON. If the result is YES and the photoelectric switch SW1 is ON, a going-into time $t_1 = t_i(n)$ (the going-into-starting time $t_{is}(n)$ or the going-into-finishing time $t_{ie}(n)$) is determined and recorded (step S22) and the timer (1) is started (step S23). Then, it is determined as to whether a predetermined time corresponding to the time to the going-out has elapsed (step S24). If the result is NO and the predetermined time has not yet elapsed, the system forces the operation to bring into a state of standby until the predetermined time has elapsed. If the result is YES and the predetermined time has elapsed, it is determined as to whether the photoelectric switch SW2 is ON (step S25) . If the result is NO and the photoelectric switch SW2 is not ON, the board identification section 4 forces the operation to bring into a state of standby until the photoelectric switch SW2 is turned ON. If the result is YES and the photoelectric switch SW2 is ON, it is then determined whether the photoelectric switch SW2 is turned OFF (step S26). If the result is No and the photoelectric switch SW2 is not OFF, the board identification section 4 forces the operation to bring into a state of standby until the photoelectric switch SW2 is turned OFF. If the result is YES and the photoelectric switch SW2 is turned OFF, an going-out time $t_2 = t_e(n)$ is determined and recorded (step S27). Then, a determination is made as to whether this t_2 can be assumed as being the scheduled going-out time (step S28). If the result is NO and this t_2 can not be assumed as being the scheduled going-out time, the operation is advanced to the system suspension (FIG. 11). If the result is YES and this t_2 can be assumed as being the scheduled going-out time, the timer (2) is started (step S29). Next, it is determined as to whether the photoelectric switch SW3 is ON (step S30). If the result is NO and the photoelectric switch SW3 is not ON, the board identification section 4 forces the operation to bring into a state of standby until the photoelectric switch SW3 is turned ON. If the result is YES and the

photoelectric switch SW3 is ON, the going-into time of the next process $t_3 = t_i(n+1)$ is determined and recorded (step S31). Then, a determination is made as to whether this t_3 can be assumed as being the scheduled going-out time (step S32). If the result is NO and this t_3 ~~can not~~ be assumed as being the scheduled going-out time, the system is advanced to the system suspension (FIG. 11). If the result is YES and this t_3 can be assumed as being the scheduled going-out time, the operation returns to the step S21.

The paragraph beginning on page 25, line 24, has been replaced with the following rewritten paragraph:

FIG. 15 is a diagram illustrating an example of the construction of the transmission packet. This transmission packet is of fixed length and consists of the preamble (PA) PI, a process number P2, a process-going-into or entry time P3, a process-going-out or exit time P4, a board image data P5, an abnormality occurrence indication flag P6, and the delimiter P7.

The paragraph beginning on page 26, line 1, has been replaced with the following rewritten paragraph:

FIG. 16 is a diagram illustrating an entire sequence of each transmission packet. In this case, the packet is represented by “provisional board number-process number”. The time axis A indicates the position of the packet in a specific manufacturing process in which the work board 1 is transferred with time. For example, as indicated by “1-3”, “2-3” and “3-3” in the manufacturing process 3, the work board having provisional numbers 1, 2 and 3 goes into and goes out from the manufacturing process 3 with time. Whereas the time axis B indicates the position of the packet as a specific work board 1 is transferred through each manufacturing process with time. For example, as indicated by “3-1”, “3-2” and “3-3”, the work board having a specific provisional number 3 ~~goes into enters~~ and then ~~goes out from exits~~ each manufacturing process with time.

The paragraph beginning on page 28, line 25, has been replaced with the following rewritten paragraph:

As a result, changes in external appearance of the work board processed or treated at each manufacturing process can be compared ~~in~~ relative to each other, so that it becomes possible to detect any non-uniformity in external appearance of the work board that might be occurred due

to the same repeated working process even if there has been no problem in the transferring of the work board. Therefore, ~~it permits to obtain~~ information which is useful is obtained for accelerating the stabilization of the manufacturing processes.

The paragraph beginning on page 29, line 4, has been replaced with the following rewritten paragraph:

Further, since a defective work board 1 is encircled by a frame, for instance, in the display thereof, the location of manufacturing process as well as the time at which the abnormality was generated can be immediately recognized. A window 86 will be displayed at the left bottom corner of the display to display a going-out time of the work board. Thus, moving a cursor to the display portion of the work board 1, and clicking the mouse button enables to display ~~a going out of the exit~~ time.

The paragraph beginning on page 29, line 23, has been replaced with the following rewritten paragraph:

~~FIG.~~ FIGS. 20 A, B, and C are ~~a flow chart~~ charts indicating the operation of the production controller 200. First of all, a determination is made as to whether the system power source is ON (step S81). If the result is NO, the system forces the operation to bring into a state of standby until the power is turned ON. If the result is YES, the initialization of the system is performed (step S82).

The paragraph beginning on page 31, line 26, has been replaced with the following rewritten paragraph:

Further, according to the present invention, it is possible to distinguish ~~it~~ an individual work board which is inherently difficult to distinguish from the others by the external appearance thereof, so that it is possible to accurately grasp the progress of working, i.e. the position of individual work board in relative to the manufacturing process. Even if a defect is found after the delivery of finished board, the manufacturing conditions thereof can be traced in detail, since it is possible to find out the accurate time when this defective product was being moved through any one of the manufacturing processes thereof.

IN THE CLAIMS:

The claims have been amended as follows:

1. (Once Amended) A surface inspection system for work boards comprising
a line sensor for ~~one demensionally~~ one-dimensionally imaging an elongated work board
in lines perpendicular to the moving direction of the work board, comprising two types of image
data sampling means, one for an odd-number sampling line and the other for an even-number
sampling line;

a velocity-measuring means for measuring a in real time the moving velocity of the work
board on each data sampling position of the line sensor;

a sampling control means for controlling the image data sampling of said line sensor in
the direction of board movement and on the basis of the moving velocity of the work board to be
measured by said velocity means; and

an image-composing memory for composing an output of said line sensor to obtain a
two-dimensional image data forming a two-dimensional image of the work board by sequentially
combining odd-line data and even-line data from the line sensor.

4. (Once Amended) The ~~surfee~~ surface inspection system for work boards according to
claim 1, which further comprises a transmitting means for assigning every work board a
transmission channel ~~to every work board~~ for sequentially transmitting periodically varying
images, assembling said image data into a transmission packet and transmitting said transmission
packet.

5. (Once Amended) The surface inspection system for work boards according to claim
1, ~~which further comprises wherein work boards pass through plurality of manufacturing~~
processes, the system further comprising:

a detecting means for detecting the work board on a work line, entry and exit of the work
board into and out of each manufacturing process;

a time-measuring means for measuring a detected time when a work board is times when
the entry and exit of the work board are detected by said detecting means, and

an identifying means for identifying the work board by means of said detected time based
on a process number representing each manufacturing process, and on times of entry and exit of
the work board into and out of the process measured by said time-measuring means.

6. (Once Amended) A surface inspection system for work product products that pass through a plurality of manufacturing processes, the system comprising;

a detecting means for detecting a work product on a work line the entry and exit of each work product into and out of each manufacturing process;

a time-measuring means for measuring a detected time when the work product is times when the entry and exit of each work product are detected by said detecting means; and

an identifying means for identifying the a work product based on a process number representing each manufacturing process, and on times of entry and exit of each work product in to and out of the process by way of said detected time measured by said time-measuring means.

Claim 7 has been cancelled

8. (Once Amended) The surface inspection system for work product products according to claim 6, wherein said detecting means detects a leading and a trailing end portion of the work product to be transferred.

Claim 9 has been cancelled.

10. (Once Amended) The surface inspection system for work product products according to claim 6, wherein said identifying means identifies the image data of the a work product going out from a manufacturing process by said manufacturing process and the time when the work product has passed through said manufacturing process based on a process number representing each manufacturing process, and on the exit time of each work product out of the process measured by said time-measuring means.

The following new claim has been added:

11. (New) A surface inspection system as in claim 3, wherein slant correction is accomplished by an affine transformation based on the angle of slant as determined by the following equation:

$$\theta = \cos^{-1} (A_0/A')$$

wherein θ equals the angle of slant, A_0 equals the width of the work board and A' equals the number of pixels.